Assessment of wind resources and annual energy production of wind farms

Hasager, Charlotte Bay

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Author: Charlotte Bay Hasager, DTU Wind Energy, Technical University of Denmark

Abstract
Wind energy provides a significant share of EU's renewable energy source. It is anticipated in the European Commission (EC), the International Energy Agency (IEA), and the European Wind Energy Association (EWEA) that wind energy expands further. Wind energy has had an annual growth of 15.6% during the last 17 years. In Denmark the plan is to increase to 50% share of total electricity consumption in 2020 compared to 26% in 2011. In EU this was 6.3% in 2011. In EU new installed wind power was 9 GW and 0.8 GW, onshore and offshore, respectively, in 2011. The total capacity in Europe is 96 GW.

At DTU Wind Energy, Risø Campus in Denmark we have contributed to research and development of wind energy for 30 years. The department has 250 employees in 2012. The presentation will address the opportunity of using Earth Observation data for assessment of wind resources and annual energy production of wind farms both onshore and offshore. The de facto industry-standard for predicting wind climates, wind resources and power productions from wind turbines and wind farms is the WAsP program www.wasp.dk. It is based on linearized atmospheric flow model equations for flow over terrain, roughness and a shelter model. A WAsP CFD model is to be released in 2012.

For the developer that plans a new onshore wind farm, there are a series of things to consider including the available land area characteristics include fauna for the environmental impact assessment, infrastructure, land cover and roughness, the orography and sheltering effects. The basic idea in WAsP will be outlined and the steps in which Earth Observation information is relevant will be detailed. This includes the digital elevation model from e.g. the Shuttle Radar Topography Mission (SRTM) that potentially may include newer radar satellite sources and airborne lidar. For roughness mapping the land cover is important and to cover larger areas satellite-based products from optical polar orbiting satellites are used, e.g. CORINE based on Landsat. Viewing capabilities of the outputs from WAsP in Google Earth with three-dimensional effects of a suggested wind farm allow visual inspection that is useful in the planning phase.

For the developer that plans a new offshore wind farm a major problem is usually lack of high-quality long-term wind data. Earth Observations for ocean wind mapping as continuous data started in 1987 with passive microwave observations (SMM/I). Scatterometer and synthetic aperture radar (SAR) observations provide ocean wind vector observations for more than 10 years. The presentation will include new results on the development and use of satellite-based wind products for wind resources assessment offshore. Finally, examples of high-resolution satellite SAR wind maps at large offshore wind farms will show the wake, i.e. reduced wind behind wind farms. This topic gains increased importance as the offshore wind farm development scales up from single projects to clusters of wind farms.

Biography
Charlotte Bay Hasager has a M.Sc. and Ph.D., and is senior scientist at DTU Wind Energy in Denmark in the Meteorology Division. She has 20 years experience in satellite remote sensing and wind energy. Currently she managers the FP7 project European Energy Research Alliance Design Tool for Offshore wind farm Clusters, and contributes to several other FP7 projects such as Norsewind, Mermaid and Marina, all about offshore met-ocean conditions. Earlier Dr. Hasager has been involved in ESA projects and many science and innovation projects. She has been president for the Atmospheric Sciences division at the European Geosciences Union for four years, among other posts.